

Hemoglobin: Normal Values

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FEW WELL-INFORMED PHYSICIANS will deny that the practice of reporting hemoglobin in terms of percentage of any one of several widely divergent standards of normal is illogical and misleading. Some recognized hematologists have published reports advocating that as little as 13.8 gm. of hemoglobin per 100 cc. of blood be considered the level designated 100 per cent; others would not use the term 100 per cent for hemoglobin content less than 17.3 gm. per 100 cc.

In an effort to learn the present status of reporting hemoglobin values, questionnaires were mailed to 44 hospitals. The hospitals selected were large, teaching, university hospitals; large government general hospitals; large, outstanding hospitals in metropolitan areas; and three outstanding hospitals in smaller communities. All are known to have laboratories directed by thoroughly competent clinical pathologists.

Thirty-three replies were received. Twenty-four replies were from hospitals in California. Obviously the hospitals in California serve a homogeneous population, are all essentially at sea level and are within an essentially common range of climate. For the sake of uniformity only, the replies from hospitals in California are used as the basis of this report (although the replies from hospitals in other states would not, if included, materially affect the data).

Of the California hospitals from which replies were received, 14 report hemoglobin both in grams per 100 cubic centimeters of blood and in percentage. Ten report only in terms of grams of hemoglobin.

The letter of transmittal which was sent with the questionnaires contained this request:

"If you do not report in terms of per cent, I would appreciate it if you would state the number of grams of hemoglobin per 100 cc. of blood you would use as 100 per cent if you did report on a percentage basis."

Three of the reporting hospitals did not answer this question.

NORM FOR REPORTING IN PER CENT

The reported basis for 100 per cent in men ranged from 14.5 to 17.2 grams with a mean of 15.3 grams. For women the basis ranged from 13.0 to 17.2 grams with a mean of 14.8 grams. Fifteen hospitals reported using the same basis for 100 per cent for both sexes.

• Hematologists are not in agreement as to the "normal" amount of hemoglobin in the blood, nor is there agreement as to what amount of hemoglobin can be considered "a hemoglobin value of 100 per cent." Different hospitals base reports of hemoglobin on different standards, which obviously can be misleading.

By biometric study of the great mass of data on hemoglobin content that has become available as a result of the blood procurement program, it should be possible to determine what "normal" values are and to provide a basis for uniformity in reporting.

From the foregoing it is apparent that Mrs. X, whose blood contained 13 grams of hemoglobin per 100 cubic centimeters would be reported by hospital A (13.0 gm. = 100 per cent) as having hemoglobin value of 100 per cent and would be reported by hospital B (17.2 gm. = 100 per cent) as having only 76 per cent. Conversely, Mrs. Y, whose blood contained 17.2 grams of hemoglobin per 100 cubic centimeters would be reported by hospital B as having 100 per cent hemoglobin and would be reported by hospital A as having 132 per cent hemoglobin.

NORMAL RANGE

Men

The lower limit of "normal" range in men varied from 12.0 to 15.0 grams per 100 cubic centimeters and the upper limit from 15.0 to 18.0 grams per 100 cubic centimeters. One hospital considers 15.0 grams hemoglobin per 100 cubic centimeters to be the lower limit of "normal," while another considers it to be the upper limit of "normal."

The narrowest "normal" range reported by any hospital was 15.0 to 16.0 grams. The broadest was 12.0 to 17.2 grams.

Women

The lower limit of "normal" range in women varied from 12.0 to 14.5 grams and the upper limit from 14.5 to 17.2 grams. One hospital considers 14.5 grams per 100 cc. to be the lower limit of "normal," while another considers it to be the upper limit.

The narrowest "normal" range for women reported by any hospital was 13.9 to 14.5 grams and the broadest was 12.0 to 17.2 grams.

The director of laboratories of one outstanding hospital reported in part as follows: "Hemoglobinometer standardized by averaging hemoglobin determination in five healthy male adults." The fallacy of such a standard will become apparent later in this report.

The most valuable reply was received from the consulting hematologist to one of the largest general hospitals on the West Coast. He sent data based upon a frequency curve such as is shown on page 204 of Todd & Sanford's "Clinical Diagnosis by Laboratory Methods," 11th Ed., 1948. (Sanford used a curve of this type to determine the probable error in carefully conducted erythrocyte counts. Such a curve has many other uses and is discussed in its more general applications on pages 331 and 340 of "Biostatistics" by W. M. Feldman, M.D., published by Charles Green & Co., Ltd., London, 1923.)

On the basis of such a curve the hematologist gave the normal range of hemoglobin in men as 14.0 to 16.5 grams per 100 cc., and in women as 12.5 to 16 grams.

Any biometric approach to the determination of "normal" hemoglobin values should be based upon a very large number of determinations, inasmuch as the probable error varies inversely as the square root of the number of observations. For example, if the probable error were computed on the basis of 1,000 observations and the probability seemed to

be undesirably great, it would be necessary to compute the probable error on 1,000 squared—or 1,000,000—observations in order to reduce the probable error by half.

This basic mathematical principle demonstrates the fallacy of trying to establish any standard on the basis of hemoglobin values in "five healthy male adults." Only by chance can such a standard have any real value.

From operations of the blood bank program the American National Red Cross now has or should have a mass of data from which authentic hemoglobin values could be computed, for the hemoglobin content of the blood of each prospective donor is determined, and only donors who are apparently in good health are accepted.

To make a biometric analysis of these data to determine mean hemoglobin values and normal limits of hemoglobin values in each sex would be a big job, but the potential value would seem to more than justify the expense.

By this means hemoglobin values for the United States as a whole could be obtained. Of probably greater importance, hemoglobin values for geographic areas differing in climate and altitude could be determined.

Once norms were established by such means and by data on so many cases, there could no longer be any excuse for the present wide divergence of opinions as to what constitutes a "normal" hemoglobin value.

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